

LITERATURE FOR 1910 ON THE BEHAVIOR OF VERTEBRATES *

JOHN B. WATSON

Johns Hopkins University

VISION

Fish In his paper, published in 1909, on light and color-vision in fishes, Hess† maintained that all the results of his experiments were in harmony with the assumption that the fishes under observation were totally color-blind. He admitted that the brightness-distribution in the spectrum is different from that of the human eye. Victor Bauer¹²⁵ has obtained certain results upon several different species of fish, which apparently are not in accord with the above conclusions of Hess. Young *Charax* were allowed to live for several days in a long, slender 'phototactic trough'. The trough was blackened upon the inner surface, with the exception of one end. This end admitted the stimulus light. Either one or two ray filters could be set up in front of this end, or any given region of the spectrum could be projected upon it. Diffuse white light was admitted from above in all experiments conducted in the dark room. The introduction of this diffuse light was necessitated by the fact that the fish were restless if the stimulus lights alone were used. Bauer tells us nothing about the intensity of this light. It has rather important bearings upon his conclusions.

Fish with *light adapted eyes*, when tested in the phototactic trough, showed no tendency to collect at the lighter of the two ends. *They were neither negatively nor positively phototactic*, and swam from the light end to the dark end and *vice versa* in a calm and restful manner. If suddenly frightened by a shadow, they attempted to hide themselves by pressing closely to the angles and edges of the glass vessel and remaining there for a time. If one brought a white paper to the unblackened end of the trough, in which the fish had dwelt for

* I have been greatly assisted in the preparation of this review by Mr. H. M. Johnson, Fellow in Psychology, Johns Hopkins University.

† C. Hess, Untersuchungen über den Lichtsinn bei Fischen. Arch. f. Augenheilk. Bd. 64, Ergänzungsheft, S. 1-38, 1909.

a long time, they would swim up to it and press themselves against the glass surface. By degrees they accustomed themselves to the new condition, and swam now here, now there. The reviewer does not know whether Bauer means here to say that the fish became positively phototactic when the paper was introduced, or whether the impulse to press against the bright end was due to what is designated "curiosity" in the higher animals. All through the paper he uses positive and negative phototaxis very loosely. The same phenomenon mentioned above, namely, indifference to photic stimuli, was exhibited by these animals in white light of all intensities except that of bright sunlight or of a very bright artificial light. When light of high intensity was admitted, the fish behaved as if frightened, and swam quickly to the darkened end. When monochromatic light, either from filters or from the spectrum, was allowed to impinge on the unblackened end of the trough, the behavior of the animals remained unchanged, until the orange region was reached. That is, they were indifferent to all regions up to orange. The moment, however, orange was admitted, a sudden change in behavior occurred. The animals were found to be strongly negative to orange and red. The point where the "*Rotscheu*" began was at 620-630 $\mu\mu$ (once at 610 $\mu\mu$). The "red-shyness" was apparent when two colored filters were used, half the undarkened end of the trough admitting red light, the other half blue light. The animals in the blue light turned the head toward the light and swam into it. Those on the red side turned the head from the light and sought to avoid it by making trial movements and swimming to the other end.

The behavior to red is completely changed by thirty minutes' *adaptation to darkness*. The fish are no longer "*rotscheu*," but behave toward all monochromatic rays exactly as they do to weak mixed light. "Die Fische schwimmen dann (bei entsprechenden herabgesetzter Gesamtintensitat) nicht nur auf Blau, Grün und Hellgelb zu, sondern auch auf Dunkelgelb und Rot." One gets the impression from these statements that the red, after the animal is dark-adapted, loses its disturbing color-value, and possesses only a white-value.

C. Hess¹³⁵, in a caustic reply to this work of Bauer, points out that he himself has shown that in certain of the forms ex-

perimented upon by Bauer, the red has very little stimulating effect; and hence, as I understand him, he would maintain that Bauer's results are due to the fact that the *light-adapted* animals react to red as they would to darkness; *i. e.*, they swim about only in those areas which appear light to them. On the other hand, when the fish are dark-adapted the red becomes supra-liminal and they react to it as to the other rays.

Bauer thinks that he was able to demonstrate the Purkinje phenomenon in three of the forms studied, but from his contradictory statements and from the arrangement of the apparatus it is extremely questionable whether the reactions were due to the presence of the Purkinje phenomenon. He concludes his paper with the rather astonishing statement that monochromatic light possesses both a color value and a brightness value for the light-adapted fish, but that the dark-adapted fish behave throughout as Hess maintains, that is, as though they were color-blind.

Reptiles and Amphibians. C. Hess¹³⁰, in a striking series of carefully conducted experiments, shows quite conclusively that the turtle, although its eyes are totally unsupplied with rods, and hence lacking in visual purple, nevertheless possesses the power to adapt itself to darkness to a very high degree. His method for proving this was a very simple one. The light-adapted animal was carried quickly into a dark-room and placed upon a table covered with dead black cloth, with its back to the apparatus admitting graded white light. This apparatus consisted of an electric light contained in a light-tight metal case. This case was supplied at one end with an iris diaphragm working over a ground glass disk. Immediately upon entrance into the dark-room the turtles were presented with a piece of meat (for control tests a small wad of cotton wool was used). The animals were guided in their responses by optical stimuli, Hess tells us, and would, since they were kept quite hungry, snap at the meat the moment it became visible. If, immediately after entering the dark-room, the diaphragm admitted sufficient light, the animals would snap at the food. If the opening were too narrow, the animals refused to strike at the food. The diaphragm was accordingly quickly opened to the point where they would snap. This reading was then taken;

time was allowed for adaptation, and the animal was again tested and the diaphragm again adjusted until the animal would snap at the food. Several determinations of this kind enabled the author to trace the whole course of adaptation to darkness.

The range of adaptive increase in sensitivity in the turtle is considerable. For example, it is so great that a dark-adapted animal can see a piece of moving meat under such conditions of illumination that it is invisible to the bright-adapted human eye. Hess finds that the whole course of adaptation is almost identical with that of the human eye when the latter is covered by a suitable orange-colored glass. The reviewer was not able to find in the article a careful description of the orange-colored glass used.

Hess made tests upon the limits of the spectrum and the brightness distribution in the spectrum, and traced the course of adaptation to colored light by a new method. An arc spectrum 20-40 cm. long, and 5-10 cm. high, was projected horizontally upon a dead-black surface. The turtles were placed upon a table with their backs to the window in the dark-room which admitted the spectrum. Food (white fish-meat, cooked rice, and in most cases, wads of cotton wool), suspended from a dead black wire, was dangled in the light in front of the animals. The food could easily be changed from one region of the spectrum to another. By moving the food over into the infra-red it was quickly determined that the width of the animal's spectrum at the red end was almost exactly the same as that of the normal human eye. Further tests on the violet end show that the reptiles have a very much shorter range there even than the hen. His final conclusion is that both hen and turtles see colors as we do, if we cover the eyes with a suitable red-yellow glass. There is this difference between hen and turtle, however: The human eye must be covered with a bright red-yellow glass which admits some of the green and blue-green wave-lengths, if it is to see the world of colors seen by the hen. It must be covered with a dark glass lying somewhat further along in the red region than the one just described for the hen, and it must restrain the short wave-lengths—*i. e.*, admitting those from the yellow only, if it is to view colors as seen by the turtle. I give these general statements because all of Hess's experimental re-

sults seem to show such a relation between human vision and reptilian vision.

Hess believes, from a histological examination of the eyes of both the hen and the turtle, that the reason for the narrowing of the spectrum at the short end is to be found solely in the physical fact that the recipient retinal elements in the one case are placed behind a film composed of red and yellow oil particles (turtles), and in the other, behind one composed of yellow and green particles (hen).

His work upon amphibians is merely summarized. He found *Diemictylus viridescens*, *Bufo vulgaris* and *Xenophus Mulleri* most suitable subjects. All three forms possess retinae liberally supplied with rods. The course of adaptation to white light in the salamander, *Diemictylus viridescens*, was almost exactly identical with that in the human eye. There was no narrowing of the spectrum at the short end, as is the case in reptiles and birds. There is no shortening in the red. They are able to see the food in the blue-green and in the red region as long as can the human eye in a similar state of adaptation.

The paper has important bearing upon theories of color vision. We have a clear proof of the functioning of a light-adaptation mechanism for both mixed and monochromatic light in a retina which is totally unsupplied with rods and hence with visual purple.

Pearse¹³⁸, in a closely articulated paper, too extended for review, gives in addition to a good historical survey of the work of other investigators, an account of several experiments upon light and heat responses of different amphibians. After giving a long list of the forms positively phototropic, he states among his conclusions that most of the species mentioned in the list gave normal photic responses after removal of the eyes and that the responses in these eyeless animals are due to the fact that the skin functions as a photoreceptor. Blue light was most effective in the production of the tropic responses in normal animals. But when eyeless individuals were tested with the same colored lights the rays toward the blue end showed no such potency as compared with those nearer the opposite end. He concludes that while both the skin and the eyes are sensitive to the whole range of the visible spectrum, color sensitiveness is present only in the latter. Spinal amphibians gave no

photic responses, but such responses were obtained in animals in which the brain anterior to the metencephalon had been excised.

Mammals. Shepherd ¹⁴¹ made an interesting series of tests upon the Rhesus monkey. The animal had to choose between bits of food (cubes of bread or rice) differing in brightness or in color tone. The colored food-cubes were soaked in color-dyes. Punishment for wrong choice was effected by soaking the bit of food which should have been avoided in a fairly strong quinine solution. The remarkable thing about the results of the experiment is the fact that the associations were formed very rapidly. The selection of a very few of the quinine-soaked cubes served to fix the correct response. If the animals were really making the discrimination upon the basis of visual stimulation arising from the differences of intensity or color-tone, and not through smell, the unintentional signs given by the experimenter or other extraneous cues, the rapidity of the rise of the discrimination, when viewed in the light of similar tests upon other animals, is little short of marvelous.

The author maintains valiantly that his tests show keen brightness discrimination, and ready discrimination of colors on the basis of hue. But the method adopted was in so many ways inadequate to solve so difficult a problem that detailed criticism and discussion of the results must await a repetition of the experiments by other means.

Waugh ¹⁴⁶ gives a belated report of his study on vision in the mouse. Both albino and black and white mice were used. The discrimination of light intensity was tested in two or three ways, under both direct and indirect illumination. The mouse distinguished differences in grays and in brightness with considerable accuracy. Red and blue objects which appear of equal intensity to the human eye are discriminated between by the mice. Red and yellow are preferred to blue and green. According to Waugh, albino mice do not show any discrimination between red and white lights. Black mice distinguish between very bright red and white of low intensity with greater difficulty than colors which are to the human eye of equal brightness. There is no discrimination between green and blue light. The mice have a poorly developed perception of form. The distance of objects is perceived within a range of 15 cm. The mice fail

to improve in estimating the depth of objects. The author makes no mention of the influence of the vibrissae in the last two tests, yet he speaks of the marked "stereotactic" instinct. One of the most obvious things to do in making such tests upon an animal which uses its vibrissae to such an extent as the mouse is to keep them clipped from birth. Not until then can one force the animal to show clearly what powers of accommodation and convergence it has. The author's findings on the anatomical side are in agreement with those obtained several years ago by Slonaker. The retinae of the mice are lacking largely in cones. There is no fovea. The range of vision is wide, and there is the possibility of a small binocular field.

AUDITION

Fish.—Bernoulli ¹²⁶ gives a clear and succinct account of the work done on hearing in fishes. His own results support the negative conclusions of Kreidl and of Korner, and are against the positive conclusions of Zenneck and of Parker. He repeated the experiments of Zenneck, but worked more carefully than the latter. A bell with C_3 for its fundamental, with a basal diameter of 94 mm. and height of 62 mm., was fastened to a very firm support with the dome immersed in water ("mit der Kuppel nach unten eingetauscht"). The bell was electromagnetically actuated. The key for closing the circuit was placed several meters away, behind a stone wall. The fish ("Forellen," also eels and individuals belonging to Zander, *Lucio perca sandra*, cuv.) were tested in an open stream, and hence under natural conditions of life. He was not able to get the slightest reactions under these conditions. "In keinem einzigen Fall haben die Forellen (*Salmo fario* L.) irgendwie auf das Lauten der Glocke reagiert."

Incidental observations showed that the fish (*Salmo fario* L. and *Thymallus vulgaris* Nilos) were totally insensitive to shrill pipes, the sound waves from which were conducted to the water by the aid of a metal tube 4 m. long and 30 mm. in diameter. Other observations showed that the fish (Zander?) were totally insensitive to pistol shots fired at a distance of 2 km. His final conclusion is that the fish do not hear, but respond tactually or visually, when at all, to the mechanical motion in the water.

Zeliony ¹⁴⁰ reports some observations made on a single kitten, which was with some difficulty taught to come from another room to be fed at the sounding of the C of a set of tuning pipes, and to inhibit the reaction to other tones. Detailed description of the learning process is not given, nor were any control tests introduced, "because before the investigation was completed, the cat had disappeared." This contribution hardly lessens the need of accurately controlled tests of auditory discrimination. The author advocates the superiority of the saliva-reflex method of Pawlow over the method of muscular reaction in tests of audition.

Swift,¹⁴² not satisfied with the conclusions of Kalischer and Rothmann as to the "psychical" character of the reactions of their dogs, trained two dogs, after the method of Kalischer, to discriminate between c' (Fresston) and e'' (Gegenton), using a trumpet on which to sound them. Fourteen days sufficed to perfect the reactions. After a month of rest the first dog's left temporal lobe was extirpated. This produced right hemianopia but did not affect the reactions to the two tones in the tests which were given three days later. Ten days later the right temporal lobe was also extirpated. This rendered the animal's blindness nearly total, and also produced left hemiplegia. Discrimination of the tones, however, was not affected. The second dog was similarly operated upon, but both temporal lobes were extirpated at once. She, too, was able to discriminate the tones as before. Swift considers that the center in question must therefore lie in some other portion of the cortex. He also argues that the reactions are not reflex as Kalischer holds, but involve an intellectual process, and a well developed "ability to think." However much we may value this opinion of the author, his anatomical findings support the conclusions of Kalischer.

Shepherd ¹⁴¹ reports that he taught Rhesus monkeys to discriminate between two noises differing mainly in intensity. In order to produce the two noises, a slat 18 inches long was fastened to the top of a box. By placing a stick vertically under the slat and suddenly withdrawing it, a fairly loud noise was produced. The intensity could be varied by varying the length of the sticks. Sticks of 3 inches and 5 inches in length were actually used. The animals were kept near by in a cage. They reacted to the stronger of the two noises by climbing upon a

platform arranged inside the cage. The apparatus producing the noises was out of sight. About 80 trials were required for monkey 4 to complete the discrimination. Monkey 6 formed the habit in 110 trials, whereas monkey 5 failed to acquire the habit in the time allotted for the experiment.

Shepherd's experiments upon pitch discrimination were quite crude. The German mouth harp was used for producing the tones. At the sound of the higher tone, A_3 (?), the monkey was expected to respond by climbing to the platform used in the intensity-discrimination test. When A_1 (?), two octaves lower, was sounded, the monkey was expected to refrain from climbing. It was not fed when the lower tone was given. Monkey 4 learned to respond correctly in three days (60 trials); monkey 6, in four days (80 trials), while monkey 5 did not learn to make the response within the time limits of the experiment.

OLFACTION

Fish. Parker,¹³⁷ experimenting on the feeding movements of the common fresh water catfish, finds that the animals remain in a state of considerable excitement after the last morsel of food has been eaten. During the period of excitement the fish swim about in the lower part of the aquarium in various directions, frequently sweeping the bottom with their barblets. In actual feeding they seldom seize food until their barblets have come in contact with it. Since they show excitement at a distance, it would seem that they scent their food. "That the olfactory apparatus really functions follows from the operative experiments of Parker. In one set of five animals he removed the barblets, thus partially eliminating the sense of taste. In another set of five he sectioned the olfactory tract and threw the peripheral mechanism out of function. When tested for one hour in a tank which contained chopped worms placed in a cheesecloth bag, the fish with barblets removed seized the food 34 times. The anosmic animals, on the contrary, did not seize it at all. A cheesecloth bag without the worms was then substituted: no fish of either of the two groups seized it. Repeated tests of this kind furnished Parker evidence for affirming that the catfish, "though a water inhabiting animal, possesses an olfactory organ that is as much an organ of smell as is the olfactory organ of the air inhabiting vertebrates."

TASTE

Amphibia. Cole ¹²⁷ suspended fresh, brainless frogs from a hook on lever device and dipped their hind feet into given solutions of chlorides of ammonium, potassium, sodium, and lithium. After a variable time the frogs withdrew the feet from the solution. The time of the reaction (from the moment of immersion to the moment of withdrawal) was taken with a stop-watch in seconds and fifths of seconds. The reaction times of the frogs to 3m., 2m., 1m., and m/2 solutions of these chlorides gave grounds for "distributing these salts into two groups—ammonium and potassium; sodium and lithium, an arrangement already indicated by their degree of concentration." The most rapid reaction occurred with the chlorides of greatest dissociation. It is suggested that the total reaction time includes two factors: diffusion time and summation time.

On the question of the receptors involved in the reaction Cole suggests without sufficient evidence that "the comparisons with the tastes of chlorides of these metals and the results of applying cocaine, suggest that nerves of a general chemical sense rather than pain nerves are affected by the chlorides."

EXPERIMENTAL AND OBSERVATIONAL STUDY OF INSTINCTS

Mammals. Yerkes and Bloomfield ¹⁴⁰ have made an interesting set of observations upon two litters of kittens, to test the definiteness of their instincts for catching and killing mice. It will be remembered that C. S. Berry, a few years ago, reported from his observations upon a litter of Manx cats that "cats are credited with more instincts than they really possess. It is commonly reported that they have an instinctive liking for mice, and that mice have an instinctive fear of cats. It is supposed that the odor of a mouse will arouse a cat, and that the odor of a cat will frighten a mouse. My experiments tend to show that this belief is not in harmony with the facts. When cats over five months old were taken into the room where mice were kept they did not show the least sign of excitement. A cat would even allow a mouse to perch upon its back without attempting to injure it. Nor did the mice show any fear of the cats. I have seen a mouse smell of the nose of a cat without showing any signs of fear." Berry concludes finally that it is through imitation that the average cat learns to kill and eat mice.

Yerkes and Bloomfield have reached wholly different conclusions from their experiments. They made their tests upon two litters of common cats. Their animals were carefully fed upon fresh milk, beef, usually cooked, and fish. They were housed in a room free from mice. In the first week of life the kittens showed no special interest in mice. Shortly after they gained their sight (12 days of age) they were again tested, but the presence of the mice did not elicit the instinctive response sought for. When slightly over four weeks of age three of the first litter of four failed to exhibit the instinct, as before. One of the kittens, however, now exhibited a type of behavior quite in contrast with that of the other three. "She noticed the mouse soon after she had been placed in the cage, as it moved near her, and quickly seized it, growling the while. The mouse escaped and the kitten gave chase, but failed to recapture it before it had climbed to the top of the cage."

Five days later the kittens were again tested. Nos. 1, 2, and 3 acted as before; No. 4, as in the above test, made efforts to catch the mouse. Two days later the test was repeated. Kittens 1, 2 and 3 showed a marked interest in the mice, but behaved as in the other tests. No. 4 exhibited almost a complete repertoire of movements used by adult cats in catching and killing mice. The mouse was pursued, caught, worried, killed, and partially eaten. The tests were continued upon the remainder of kittens belonging to the same group as No. 4, and upon four kittens belonging to a second litter. All the animals tested, at slightly varying ages, exhibited the characteristic instinctive behavior of No. 4. The instinct to kill commonly appears at about the end of the second month. It may appear as early as the end of the first month. Since Berry worked with kittens five months old, his negative results were probably due to the fact that the instinct had waned through disuse.

A. Franken,¹²⁸ in an exceedingly long and diffuse paper, reports some tests on the intelligence of the dog, which are much like those made by Hobhouse several years ago. It is singular that Hobhouse is not quoted as a reference. Thorndike and Lloyd Morgan are the only English references given. Some of the principal statements made by the author are as follows: The characteristic instinctive movements of the dog are concerned directly with the goal (obtaining of food). His method

of attack is a random one ("Probiermethode"). The problem is not learned by one successful solution, but by many repetitions. During the learning process involuntary attention is withdrawn more and more from the goal, and is directed toward the method of arriving at the goal. Changes in the arrangement of the apparatus call out new trial movements. Check experiments ("Vexierversuche") following too closely upon one another tend to break down the reaction.

The author makes a distinction between sensory and motor reactions which is not clear to the reviewer. He says that motor reactions predominate, and that sensory reactions are called out only by some external demand ("*aussere Notigung*") If the external demands are continuous and compelling, the dog can accustom himself to the sensory reaction. I presume this statement refers to the fact that the dog can learn to discriminate between the different cords, strings, etc., used in the experiments.

His conclusions concerning the general levels of intelligence of the dog are not far removed from those of Thorndike. The dog shows no evidence of reflection. There was little evidence even of sensory thought ("Nur in einigen wenigen Versuchen aussert es sinnliches Denken, das allerdings bis zu einem gewissen Grade einer Erziehung fähig ist.")*

Birds. Herrick,¹³⁴ in an admirable study of the young and adult cuckoo, largely increases our knowledge of the first appearance, the development, and method of functioning of instincts in birds. The paper shows quite clearly how much valuable work can be done by a study of animals in their natural environment. The instinctive activity of the birds studied is too complex and detailed to be reviewed fully. The author's especial interest centers about the peculiar instinct in the adult cuckoo, to lay its eggs in the nests of other birds. Herrick would find the origin of "parasitism" in many of the old world cuckoos and in the American cow-bird, in the disturbance of the cyclical reproductive instincts; in particular, that of the attunement of egg-laying to nest-building. This maladjustment shows itself in the laying of the eggs before the nest is ready to receive them, and in laying them at very irregular intervals. For example, the

* It is somewhat surprising that an important psychological journal should have been willing to devote more than 100 pages to an article which judged by our American standards does not rise above the level of the ordinary student's 'note-book.'

interval in *Cuculus canorus* is sometimes six to seven days. This makes brooding almost impossible. Even the American cuckoo, which builds its own nest, broods its own eggs and cares for its own young, shows a strong tendency to lay eggs at irregular intervals. Brooding is made possible, however, in the American cuckoo, by the presence of a compensatory instinct in the young, which, after a short stay in the nest, crawl out in the order in which they were hatched, and pass through a climbing stage. The reason for the disturbance in the reproductive cycle cannot be stated, but it is probable that it is independent of food-habits.

Herrick's three other papers¹³⁴ form the best discussion we have at the present time of instinctive action in birds. This valuable observational material ought to stimulate further experimental work of the type begun by Breed in the Harvard Laboratory.

ORIENTATION

Fish. Greene¹³¹ by means of an aluminum button attached to the caudal fin, was able permanently to mark a number of salmon entering the mouth of the Columbia River. By this means the author hoped to study the length of time spent by the fish in the tidewater regions after entering the mouth of the river, and to determine the speed of individuals after the tidal area had been passed. The success of the experiment depended upon the fact that the commercial fisheries stationed along the river would recapture the marked individuals, and return the tag to the author. The aluminum button corrodes in salt water. The length of time spent in the tidal regions could thus be approximately gauged by the amount of corrosion showing on the button. Fifty-nine fish were marked, and 17 retaken. The conclusion arrived at by the author is that from 30 to 40 days were consumed by the fish in crossing the tidal area (a much longer time than was formerly supposed); and that once the fish had passed the tidal area, they made the journey up the river at an average speed of not less than seven and one-half miles a day.

Victor Franz¹²⁹ maintains that fish have an extraordinarily well developed sensitivity to differences in hydrographic conditions. Currents are detected by means of the lateral line organs; temperature, through the warm and cold corpuscles in the skin; salinity, through the sense of taste; depth through pressure and vision. The paper is a resumé and not a report of

experiments. His chief argument is that the spawning migration is not actuated by any sexual instinct, but is an adaptive change which has as its end the obtaining of optimal developmental conditions for the young. It is conditioned solely by hydrographic phenomena.

Thauziés¹⁴³ gives the record in detail of the homing pigeons released by him at Geneva when the Sixth International Congress was in session. Birds belonging to the three cities, Versailles, Guéret, and Gannat were used. None of them had flown from Geneva previously. The birds from Versailles had been trained toward Brest, those of Guéret towards Amsterdam, and those from Gannat, towards Macon.

Versailles: 24 birds were released August 6: two returned the same day at about 5:45 P. M.; nine returned August 7 at different hours; by the 10th of August all the birds had returned.

Guéret: 38 released at 7:15 A. M., August 6; two returned the same day a little after noon. The rest returned on the following morning.

Gannat: eight pigeons were released at 7:20 A. M., August 6. None returned the first day. On the 7th of August three returned in the morning; one on the 8th, and one each on the 9th, 11th and 12th. One had failed to return by the 17th.

Hachet-Souplet¹³² reports a set of experiments made upon pigeons reared in movable cotes. The pigeons were taken from the wagon at a point A and placed in a basket. The outside appearance of the wagon was of course familiar to the birds. The "traveling cote" was then driven to a point B, 5 km. from A. The pigeons were released. They quickly found the cote at B. The experiment was then repeated with the distance between the two points increased to 10 km. Care was always taken to place the wagon, covered with a large drapery, in an open place. The birds invariably found it at this distance. The moment 10 km. is exceeded, a decrease in the number of returns is noticed. No returns were obtained from distances greater than 12 km.

Now, by proceeding in another way, the birds may be made to return to the wagon from much greater distances. On leaving the point A, two birds are attached to the outside of each wagon by a cord in such a way that as the wagon travels they can view the surrounding country. The string permits the

bird to rise to a height of 35 meters. On arrival at the point B, the bird is allowed a few moments in which to "take note" of the present surroundings of the cote. It is then put into a covered basket, sent back to the point A, and released. On the first trial a successful return of eight birds from a distance of 100 km. was obtained. The ten pigeons which had been transported inside the wagon failed to return when given this test. The author tells us that these experiments have been repeated many times.

Watson¹⁴⁵ continued his tests on the homing sense of the noddy and sooty terns during the season of 1910. The weather was unfavorable for the work. Birds of both species were released in New York harbor, Galveston, and Mobile. All were in poor condition on their arrival at these ports, and none returned to Bird Key. Two out of three noddies released in mid-ocean between Bird Key and Galveston (460 miles due west from Bird Key) returned at the end of three days. These returns are significant by reason of the fact that all possibility of return through the help of visual familiar clues apparently is excluded. One out of a group of four sooties released at night en route to New York, 365 miles northeast from Bird Key, returned at the end of four days, and one other possibly returned after the experimenter left the island.

Cyon's hypothesis of a special nasal sense was tested by closing tightly with asphaltum the outer nasal chambers of two noddies, and releasing them at Key West, 65½ miles due east of Bird Key. Both birds returned in normal time. The nasal chambers were still tightly closed with the asphaltum when the birds were retaken on their nests the following morning. Out of a group of twelve noddies and twelve sooties released in Key West, all twelve noddies returned, but only ten of the sooties. The time of the return varied from 17½ hours to 11 days.

Thauziés¹⁴⁴ argues for the presence of a magnetic sense in the homing pigeon. He presents no critical experiments which would further such an hypothesis. The only observations seeming to support his case are as follows: On 18 August, 1907, the homing pigeon fanciers of Pir released at Orleans, 320 km. distant, at 6.30 A. M., 99 young pigeons. The day was clear, calm, and hot. Up to the date mentioned, the birds had been

satisfactory fliers. The first birds, only eleven in all, arrived at 2.20 P. M. The rest returned the following morning (the trip requires about five hours). Several other societies in the region reported similar irregularities in return. On 22 July, 1906, several young pigeons had been released 65 km. from their cote. These were well trained birds. They would normally require slightly less than one hour to make the trip. On this date the birds first appearing required three hours, and many did not return at all.

Examination of the meteorological conditions of the two days showed a violent magnetic storm on each, and great heat. Thauziés maintains that the heat does not affect the birds. He attributes their abnormal behavior to a disturbance of their magnetic sensibility.

IMITATION.

Mammals. Witmer¹⁴⁷ cites the act of a monkey (*M. cynomolgus*) in opening a door of a greenhouse as one involving intelligent imitation. According to the author, the monkey did not have to learn the act by trial and error, since she opened it at the first attempt. This monkey learned also to open the door of a cage, as well as the door leading into another room, the knob of which she could reach through the bars of the cage. "This door was partly of glass, and through it she could look into the adjoining room. On one occasion I saw her observe intently some people in this room who were about to come into the room containing her cage. She reached through the bars of the cage, turned the knob of the door, pushed the door wide open, and sat waiting on her haunches with expectant gaze. There could be no doubt that she had conceived in her mind the entrance into the room of the persons whom she saw in the adjoining room, and it looked as though she had opened the door for the purpose of allowing them to enter." Witmer cites other observations of the same type.

This paper, as well as the one by the same author on "Peter,"¹⁴⁸ is a return to the worst type of anecdotalism. It is sincerely hoped by the reviewer that the work appearing on animal psychology from this laboratory, which apparently yields such prodigious and interesting results with such a slight expenditure of energy, will not be considered seriously until there is shown

some tendency on the experimenters' part to control their experiments, and to consider in some measure the work of other investigators.

Shepherd ¹⁴¹ repeats on the Rhesus monkey two of the imitation tests made by Hobhouse and by Watson. Pushing food from a glass tube was the first test given. The animals failed to show any signs of imitating the movement of the experimenter. The simple act of pulling in food with a T-rake was the next tried. Six of the animals failed in it. Two of the monkeys seemed after a few days to give some evidence of imitation. They learned to imitate the experimenter in pushing out the rake, perfectly, but the pulling in of the food with the rake remained imperfect to the last. A third and new type of experiment was next tried. A banana was suspended out of reach of the animal. By pushing a sliding pole arranged to work in a horizontal plane two feet six inches from the floor, to the right or to the left until it lay in the same vertical plane as the banana, and then mounting upon it, the animal could reach the food. The monkey longest tested in this experiment slowly improved, apparently by virtue of the tuition afforded him by the operator.

Birds. The work of Porter ¹⁴² is concerned with learning in several species of birds not hitherto extensively studied, *e. g.*, the junco, numerous varieties of sparrows, Baltimore orioles, blue jays, bluebirds, and crows. The author's chief interest in the work centers around the problem of imitation. His method of testing imitation differs from the methods of other investigators, in that the "imitator" was never confined. Porter allowed several of the birds to work together, displacing each other at the task whenever opportunity afforded. He states that this method introduces such motives as rivalry, competition, struggle, fear, "new caution," interest and attention. The writer's description of his method is unclear. His preliminary work gave him a new criterion of imitation, which I quote in full: "Early in the present work the writer began to make use of the criterion of the presence of imitation which may be stated somewhat as follows: Bird No. 1 is induced to open a box, which may be done in one of several different ways. Bird No. 2, by the means indicated above, is allowed to supplant No. 1. The effect of this different method of opening on the

behavior of No. 1 is closely observed and recorded. The behavior of No. 2 will rarely be identical repetition. We may be fairly certain, then, that No. 1 will have furnished to him by No. 2 or *vice-versa*, an example or act to imitate."

Porter states that he found satisfactory evidence of the presence of imitation in most of the birds tested except the blue jays. There was some evidence that members of the same species imitate each other more closely than members of different species.

HABIT FORMATION

Mammals. Glaser ¹³⁰ succeeded in obtaining the rapid formation of habits in the white rat by a rather ingenious method. A zinc tank about two feet square and six inches deep was covered with coarse wire netting and filled with water. A circular opening was made in the center of the wire gauze and fitted with a cylindrical shoot. Each of the four corners of the cover was supplied with a small opening covered with a hinged door. Any one of these openings, at will, could be made the true exit from the maze. The time record of the escape from the labyrinth was taken and a plot made of the animal's path. In addition to the data obtained upon habit formation under these novel conditions interesting comparisons are made between the adults and the young with respect to the rapidity of habit formation. The facts obtained on the rat's use of its senses in the maze support in the main the work of other investigators.